PTO/SB/05 (4/98)

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Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	500.38695X00
First Inventor or Application Identifier	Masaaki TANIZAKI
Title	See 1 in Addendum
Express Mail Label No.	

APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231**

1. [X] * Fee Transmittal Form *(e.g., PTO/SB/17)* *(Submit an original and a duplicate for fee processing)*
2. [X] Specification [*Total Pages* 24] *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) *(35 U.S.C. 113)* [*Total Sheets* 16]
4. Oath or Declaration [*Total Pages* 4]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 16 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

NOTE FOR ITEMS 1 & 13 IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

5. [ ] Microfiche Computer Program *(Appendix)*
6. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Copy
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ACCOMPANYING APPLICATION PARTS

7. [X] Assignment Papers (cover sheet & document(s))
8. [ ] 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* [X] Power of Attorney
9. [ ] English Translation Document *(if applicable)*
10. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
11. [ ] Preliminary Amendment
12. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
13. [ ] * Small Entity Statement(s) *(PTO/SB/09-12)* [ ] Statement filed in prior application Status still proper and desired
14. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
15. [X] Other: See 2 in Addendum

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Attachment to PTO/SB/05 (4/98) Utility Patent Application Transmittal

1. DISPLAY METHOD OF SPATIAL DATA RELATIONSHIP
2. - INF. UNDER 37 CFR 1.56(A) W/REFS.

DISPLAY METHOD OF SPATIAL DATA RELATIONSHIPS

BACKGROUND OF THE INVENTION

Public utility enterprises for electric supply, gas supply, communication service, etc. and the waterworks/sewerage management divisions, public works divisions, etc. of local governments need maps and facility drawings for performing the maintenance and management of their facilities. Up to date, such enterprises and local governments have proceeded with data reduction or consolidation through the digitalization of maps and facility drawings.

On the other hand, the progress of network-related technologies represented by optical communication networks, ATM and so on is bringing forth the recent situation in which the communication of a large volume of data on the Internet environment is enabled. Therein, the handling of map information requiring a large capacity is now realizable.

In such circumstances, it is desired that maps and facility drawings managed by individual organizations are communized through the Internet to improve the efficiency by substituting the on-line communication of data for the off-line data data communication which has hitherto been made. Namely, each enterprise or organization manages its facility drawings but is not concerned in the management of facility drawings which are to be managed by another enterprise or organization.

Therefore, what is to be done by each enterprise or local government when an actual construction work is to be executed, includes collecting the drawings of individual facilities installed at a location to be subjected to construction work and making the registration or superimposition of the facility drawings to grasp the arrangement of facilities.

This registration of facility drawings requires a user not only to simply unify the coordinate systems and units of facility drawings provided from respective enterprises and local government but also to select user's desired objects or targets from among these drawings with different contents of description so that the selected objects are displayed in a superimposed manner. Normally, map information on facility drawings or the like includes an assembly of plural objects classified for the respective types of subjects. Also, different names/definitions are respectively employed by the organizations or enterprises possessing the facility drawings. Accordingly, the above-mentioned selection of user's desired objects is not easy.

SUMMARY OF THE INVENTION

Up to date, the activities for standardization by ISO/TC112, Open GIS and so on have exhibited, for example, the notation of the location and outline of map information by meta data, and the prescription of a common interface between different types of GIS's by a

distributed object technology.

For actual realization of the mutual utilization of map information, however, it is necessary to make, with respect to the respective objects included in map information provided from different organizations, the determination of how are they associated with an object architecture used in an organization to which the user belongs, as mentioned above. In connection with this, the existing conditions are such that the association of objects with each other (or the generation of a relationship) is made relying upon a manual work by the user.

Thus, the present invention provides an interface in which when different organizations or enterprises desire to share their held map information therebetween, meta data describing the property of each map information is interpreted to make the association of objects between its own organization and another organization and the procedure for unification for differences in coordinate system and unit therebetween, thereby allowing a user to decide the optimum relationship easily.

These and other objects, features and advantages of the present invention will become more apparent in view of the following detailed description of the preferred embodiments in conjunction with accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows the overall construction of a system of the present invention;

Fig. 2 shows the construction of the system on the Internet environment;

Fig. 3 shows application definition data;

Fig. 4 shows object hierarchical structure data of application;

Fig. 5 shows object property structure data of application;

Fig. 6 shows server definition data;

Fig. 7 shows object hierarchical structure data of server;

Fig. 8 shows object property structure data of server;

Fig. 9 shows the flow of a relationship generation processing;

Fig. 10 shows an interface for displaying relationships;

Fig. 11 shows the flow of an object relationship generation processing;

Fig. 12 shows thesaurus data;

Fig. 13 shows object relationship data;

Fig. 14 shows the flow of a processing for generation of property relationships between objects;

Fig. 15 shows property relationship data;

Fig. 16 shows the flow of an object structure conversion processing; and

Fig. 17 shows an example of object retrieval on the relationship displaying interface.

DESCRIPTION OF THE EMBODIMENTS

Embodiments of the present invention will now be described. Fig. 1 is a diagram showing the construction of a system for performing a relationship display processing according to the present invention. Reference numeral 1 denotes a central processing device for performing each program, numeral 2 an indication device which a user operates, numeral 3 a display device for displaying the result of execution of each program, numeral 4 a program memory for storing programs required for processings performed by the central processing device 1, and numerals 5, 6 and 7 data memories for storing data used by those programs.

The program memory 4 is stored with four types of programs including an application definition data retrieving program 11 for retrieving each data from the data memory 5, a server definition data retrieving program 12 for retrieving each data from the data memory 6 or 7, an object relationship generation program 13 for generating relationships between objects defined by an application and objects defined by a server, a property relationship generation program 14 for generating relationships between properties possessed by the respective objects related or associated with each other, and an object structure transformation program 15

for transforming or converting an object provided from the server into an object structure defined by the application.

The data memory 5 is stored with four types of data as follows. Reference numeral 21 denotes application definition data representing the outline of an application, numeral 22 object hierarchical structure data representing the hierarchical structure of objects applied in the application, numeral 23 object property structure data representing what property architecture does each object possess, and numeral 24 thesaurus data representing a relationship between names, the thesaurus data being used in an object relationship generation processing.

Each of the data memories 6 and 7 is stored with four types of data as follows. Reference numeral 31 or 41 denotes server definition data representing the outline of a server represented by that data memory, numeral 32 or 42 object hierarchical structure data representing the hierarchical structure of objects provided from the server, numeral 33 or 43 object property structure data representing what property architecture does each object possess, and numeral 34 or 44 object data representing data of the actual map or drawing.

Next, the description using Fig. 2 will be made in conjunction with the exemplified case where the system construction shown in Fig. 1 is applied to an

interactive operation between a gas company and the waterworks management division of a local government.

In the construction shown in Fig. 2, a gas pipe utility management enterprise 201 and a local government 203 are connected through the Internet 203. The gas pipe utility management enterprise 201 includes a gas pipe utility management server 213 which corresponds to the data memory 6 shown in Fig. 1 and manages maps/drawings, a mediator 212 which corresponds to the central processing device 1, the indication device 2, the display device 3, the program memory 4 and the data memory 5 shown in Fig. 1, and a client terminal 211 which executes various application programs. It is general that within the same enterprise, the data consolidation and application development are made on the basis of object definition which is equal between a server and an application. Under this premise, it is assumed that in the same enterprise, the above-mentioned application definition data and server definition data are equal to each other and each of the above-mentioned object hierarchical structure data and object property structure data is equal between the application and the server. On the other hand, the local government 202 includes a waterworks management server 221 which corresponds to the data memory 7 shown in Fig. 1 and manages waterworks-related maps/drawings based on object definition different from that in the gas pipe utility management enterprise.

In substance, the shown system construction is encompassed with a group of servers of many other organizations/enterprises connected to the Internet 203 in order to effect the mutual utilization of individually held maps, drawings and so on therebetween. For simplicity of illustration, however, the description will herein be made with only one of other servers made an object of interactive operation. Also, the system provided by the present invention is applicable to not only the interactive operation on the Internet environment but also the interactive operation of maps and drawings between a plurality of sections or divisions in an enterprise or organization. In the latter case, the Internet 203 is replaced by an intranet.

Further, each server may employ a variety of forms as software for managing maps and drawings. However, it is herein assumed that there is equipped a wrapper program by which a map or drawing provided from each server is converted into the form of object. An example of the structure of the wrapper program may be a system in which it is developed in accordance with the interface prescription indicated by the Open GIS.

Now, the structure of each data in the system construction shown in Figs. 1 and 2 will be described using Figs. 3 to 5 which show data defining applications and Figs. 6 to 8 which show the contents of data provided from servers.

Fig. 3 shows the data structure of application definition data which corresponds to 21 in Fig. 1. There is shown the specification of applications used in the gas company. Referring to the data structure 301 shown in Fig. 3, it has, for each application, items which include name of application, coordinate system, area of operation, name of target object, and so on. A plurality of such applications are provided in accordance with each work and target (or applied) objects are specified for each application.

Objects applied in each application normally take a hierarchical structure. A parent/child relationship between objects in the hierarchical structure may include an is-a relationship and a part-of relationship. Herein, an example of a construction having association based on the is-a relationship is shown by 401 in Fig. 4. A data structure for representing the hierarchical structure is shown by 402 in Fig. 4. With each object taken as a node, it includes node name, parent node ID and child node ID.

As shown in Fig. 5, each object is composed of a plurality of properties and each property may include numerical type data such as integer and short, character string type data such as string, and figure type data such as line and plane representing figure data. Reference numerals 501 to 504 denote the respective data structures of objects applied in a gas facility management application and each data structure includes

numerical type data, character string type data, and figure type data in the case of an object with a figure. Namely, it is meant that in a program of the gas facility management application, only objects based on those data structures are made an object of processing. Figs. 4 and 5 correspond to 22 and 23 in the system construction shown in Fig. 1.

Next, the description will be made of data provided from the servers. Each server holds server definition data, as shown by 601 or 602 in Fig. 6, which represents the outline of map/drawing information provided from that server. The server definition data has items including the name of a server, a coordinate system on which figure data depends, a management area which represents the area of data managed by the server, and so on. Such server definition data is registered in each server. Namely, the server definition data 601 corresponds to 31 in Fig. 1 and the data 602 corresponds to 41. In the example shown in Fig. 2, the data 601 is stored in the gas pipe utility management server 213 and the data 602 is stored in the waterworks management server 221.

Objects described in the server definition data (or indicated in the item of object name) take a hierarchical structure based on association such as an is-a relationship, a part-of relationship or the like, as in the case of the object hierarchical structure data of application mentioned above. Hierarchical structure

data concerning the objects defined by the server definition data 602 shown in Fig. 6 is shown in Fig. 7. For contents, the hierarchical structure is described as a data structure in which a parent/child relationship between nodes is described, in a manner similar to that in Fig. 4. The data structure is stored in the corresponding server. Namely, if the waterworks management server corresponds to 7 in Fig. 1, Fig. 7 shows the contents of 42 in Fig. 1.

Reference numerals 801 to 803 in Fig. 8 denote the respective property structures of objects described in the above-mentioned server definition data. This structure shows the data structure of each object provided from the corresponding server and each property includes numerical type data, character string type data, figure type data or the like. Real data according to those property structures is stored as object data in each server. Namely, the object property structure data and the object data are stored in the gas pile utility management server 213 or the waterworks management server 221 in Fig. 2.

The server definition data, object hierarchical structure data, object property structure data and object data described in the above are normally defined such that each data has a matching between an application and a server in the same enterprise or organization. However, when a connection is established between different enterprises or organizations, as shown

in Fig. 2, it is of course that no matching is obtained in many cases. Thus, in the present invention, the association of objects different in hierarchical structure and/or property structure between the server and the application is made by performing a processing for generation of a relationship between objects. The object relationship generation processing will subsequently be described. By performing a conversion processing based on this association, objects different in definition between the enterprises or organizations are made mutually available. The relationship generation processing according to the present invention will now be described.

A procedure for generating relationships between objects provided from a plurality of servers and objects defined on the application side so that they are decided by a user on an interface will be described by use of Fig. 9. Fig. 10 shows the interface in this case. In the processing shown in Fig. 9, definition data and hierarchical structure data of application and those of server are first acquired or retrieved (steps 901 and 902). Next or in step 903, relationships between objects of application and objects of server are generated on the basis of a system which will be mentioned later on. The confirmation is made of whether or not the relationships obtained in step 903 are the optimum. More particularly, the user's indication operations shown in steps 906 to 908 are performed to

modify the generated relationships, as required, thereby deciding the optimum relationships. The modification and confirmation of the object relationships obtained in step 903, the modification and confirmation of relationships between properties possessed by the associated objects, and the modification and confirmation of relationships while actually displaying figure data possessed by object data are respectively made in steps 906, 907 and 908 by use of an interface which will subsequently be described.

Fig. 10 shows the interface which performs the above-mentioned indication operations. The interface includes an application selecting menu for displaying a plurality of applications in the form of a list to select an object of operation by use of an indication device, and a server selecting menu for displaying a plurality of servers in the form of a list to select an object of operation by use of the indication device. The names of applications and servers acquired in steps 901 and 902 in Fig. 9 are displayed as the application and server lists. In Fig. 10, a situation is shown in which a gas facility management application is selected by the application selecting menu and a waterworks management server as a server corresponding to the selected application is selected by the server selecting menu.

The interface further includes an application object hierarchical structure indicator for displaying

the names and hierarchical structure of objects applied in the application selected by the application selecting menu, and a server object hierarchical structure indicator for displaying the names and hierarchical structure of objects provided from the server selected by the server selecting menu. Data shown in Fig. 4 and data shown in Fig. 7 are displayed on those menus on the basis of that view such as is-a hierarchy, part-of hierarchy or the like in a list of the types of object hierarchy displayed by a view selecting menu which the user selects by use of the indication device. In Fig. 10, the hierarchical structure data of objects defined by the gas facility management application and the hierarchical structure data of objects provided from the waterworks management server are displayed on the application and server object hierarchical structure indicators, respectively.

On an object relationship indicator located between the application and server object hierarchical structure indicators, there are displayed relationships between the application objects and the server objects on the basis of the result of processing in step 903 in Fig. 9. At this time, for exhibiting the order of the degree of certainty of the relationship (or the degree of association between objects) to the user, lines indicating the relationship are displayed with the thickness or type thereof distinguished in accordance with the value of similarity obtained as the result of

the processing for generation of relationships between objects. In the example shown in Fig. 10, the relationship having the similarity equal to 1 is displayed by solid line and the relationship having the similarity equal to α is displayed by dotted line. The details of the processing for generation of relationships between objects will be mentioned later on.

In order to displaying relationships between the property structures of objects associated by the object relationship indicator, the interface is further provided with an application object property structure indicator and a server object property structure indicator. The property structure of an object selected on the application object hierarchical structure indicator is displayed on the application object property structure indicator, and the property structure of an object selected on the server object hierarchical structure indicator is displayed on the server object property structure indicator. On a property relationship indicator located between the application and server object property structure indicators, there are displayed relationships between the application object properties and the server object properties on the basis of property relationship data obtained as the result of a property relationship generation processing which will be mentioned later on. As required, the user is urged to confirm the displayed relationships.

The final confirmation/decision of the

relationships between objects is made in such a manner that object data of areas designated by an input field of retrieving area (or a retrieving position designator) is actually displayed on an application object indicator and a server object indicator located at a lower portion of the interface. The retrieval and display of object data requires the conversion of figure data inclusive of coordinate system and unit different for each server and the conversion of property data. The details of such conversion will be mentioned later on.

The flow of the object relationship generation processing will now be described using Figs. 11, 12 and 13. This processing corresponds to step 903 in Fig. 9. In the present processing, the collection of application definition data acquired in step 901 in Fig. 9 and the collection of server definition data acquired in step 902 are subjected to the generation of relationships between objects defined by both the definition data. First, the generation is repeated for each retrieved application Ai (step 1101) and for each object Oik defined by the application Ai (step 1102). In step 1103, thesaurus data shown in Fig. 12 is searched with the name of the object Oik used as a key. The thesaurus data includes target words, synonyms equivalent in sense to the target words, narrow sense words narrower in sense than the target words, and wide sense words wider in sense than the target words. Herein, the replacement of the name of the object Oik by synonyms, narrow sense

words and wide sense words is made using the thesaurus data. And, the assembly of words obtained by the replacement is compared with objects defined by the server definition data. For this purpose, the comparison of the name of the object Oik defined by the application Ai and the name of an object Ojl defined by a server Sj is made for each retrieved server definition data and for each object defined by that server definition data (steps 1104 to 1106). At this time, the similarity is applied for the combination of names the comparison of which results in a matching (step 1107). In the case where the matching with the synonym is obtained, the similarity is set to 1. In the case where the matching with the narrow sense word is obtained, the similarity is set to α. In the case where the matching with the wide sense word is obtained, the similarity is set to β. The similarities α and β are defined to be decimals smaller than 1. Next, property relationships between Oik and Ojl associated with each other are determined (step 1108). This is a processing for generating relationships between properties defined by the object Oik and properties defined by the object Ojl. The details of this processing will be mentioned later on. In step 1109, the application Ai, object Oik, server Sj, object Ojl, similarity and property relationship obtained as the result of the above processing are saved or returned. The resulting object relationship data is shown in Fig. 13. With the foregoing process,

it is possible to determine which of objects provided from the server is applied in the application. Next, the description will be made of a processing for generating relationships between property structures among objects associated or related with each other through the above processing.

The flow of the processing for generation of property relationships between objects will be described using Figs. 14 and 15. This processing corresponds to step 1108 in Fig. 11. It is determined which one of properties possessed by one of the related objects Oik and Ojl does a property possessed by the other object correspond to. More particularly, the application object Oik and the server object jl related with each other are subjected to the following. First, provided that properties possessed by Oik are Pm, the thesaurus is searched for each property Pm (that is, successively with respect to all m's) to retrieve synonyms for which the name of that property Pm matches with the target word. Subsequently, for each of properties Pn held by Ojl, the judgement is made of whether or not the name of that property Pn matches with the retrieved synonym. In the case where the matching is obtained, the judgement is made of whether or not Pm and Pn have the same domain. The domain herein referred to indicates the classification of a data type possessed by the property and may include numerical type, character string type, figure type and so on. With the above judgement, the

combination of properties having their names equivalent in sense and their data types belonging to the same classification is determined. By thus making the judgement with respect to all combinations of Pm of Oik and Pn of Ojl, the property relationships between Oik and Ojl are generated. As a result, there is obtained property relationship data, as shown in Fig. 15, which is composed of application object names, server object names, and the names and data types of related properties Pm and Pn.

With the object relationship generation processing and the property relationship generation processing mentioned above, it is possible to determine relationships between objects provided from each server and objects defined by an application based on names and data structures. In addition thereto, the present invention makes the determination of relationships based on the contents of figure data possessed by objects. For that purpose, the present invention provides a processing and an interface with which the result of display of actually retrieved objects is offered to the user for confirmation. This will now be described using Figs. 16 and 17.

Fig. 16 shows the flow of a processing for converting object data retrieved from the server into an object structure defined by the application. In this processing, for a figure property possessed by an object, the conversion of figure data is made on the

basis of the values of coordinate system, unit and so on described by the application definition data and the server definition data. For properties except the figure property, on the other hand, the conversion of the type and value of each property is made on the basis of property relationship data obtained as the result of the property relationship generation processing shown in Fig. 14.

Fig. 17 shows an example of display on the interface on which object data obtained as the result of conversion processing mentioned above is displayed to obtain the confirmation by the user. On the application object indicator, there is displayed the superimposition of object data of an object selected on the application object hierarchical structure indicator and figure data of an object selected on the server object hierarchical structure indicator which figure data is data after conversion. On the server object indicator, on the other hand, only an object selected on the server object hierarchical structure indicator is displayed. With these indicators, it is possible to make the confirmation of what figure data does a server object possess and the confirmation of a situation when the server object data or figure data is displayed together with another object data in a superimposed manner on the application object indicator. On the basis of such result of display, the user can judge whether or not desired map information is obtained and it is therefore

possible for the user to make the proper selection of a server and a server object.

After user confirmed the object relationships, child objects of related objects and objects subsequent to the child objects are omitted. For example, manhole object and gas pipe object would be hidden in Fig. 17.

According to the present invention described in the foregoing, there is provided an interface in which the optimum relationships between objects provided from map servers distributed on the Internet environment and objects defined by a desired application are generated and a work of confirmation and modification by a user can easily be done. Thereby, a cost required for a complicated relating procedure indispensable to an interactive operating system is reduced.

While the present invention has been described above in conjunction with the preferred embodiments, one of ordinary skill in the art would be enabled by this disclosure to make various modifications to this embodiment and still be within the scope and spirit of the invention as defined in the appended claims.

WHAT IS CLAIMED IS:

1. A map relationship displaying method comprising the steps of:

acquiring server definition data representing the outline of a server;

acquiring application definition data representing the outline of an application;

generating a relationship from said server definition data and said application definition data;

displaying a list of said server definition data and a list of said application definition data on display means;

displaying, object hierarchical structure data of said server, object hierarchical structure data of said application, a relationship between an object of said server and an object of said application, and object data retrieved from said server, on said display means; and

deciding the relationship on the basis of a confirmation operation inputted from indication means.

2. A map relationship displaying method according to Claim 1, wherein in displaying the object hierarchical structure, the form of display is changed depending on the type of a parent/child relationship between objects.

3. A map relationship displaying method according to Claim 1, wherein in displaying the object hierarchical structure, an object of the lowermost layer

and an object of an intermediate layer are distinctively displayed.

4. A map relationship displaying method according to Claim 1, wherein in displaying the object relationship, the similarity of the relationship is displayed in a form reflected by the type of line or the thickness of line.

5. A map relationship displaying method according to Claim 1, wherein the object relationship is displayed so that child objects of related objects and objects subsequent to the child objects are omitted.

6. A map relationship displaying method according to Claim 1, wherein the object relationship is displayed in the order of a degree of certainty representing the height of degree of association between objects.

7. A map relationship displaying method according to Claim 1, wherein the object hierarchical structure and/or the object relationship are displayed with distinction for each view selected by a user.

ABSTRACT OF THE DISCLOSURE

For interactive operation between different enterprises or organizations, it is necessary to provide high-quality map information by not only displaying the results of retrieval from the map information servers of those organizations in a superimposed manner but also performing distributed retrieval on the basis of a relationship matched in sense between the servers. Thus, an interface is provided in which the optimum relationships between objects provided from the map servers distributed on the Internet environment and objects defined by a desired application are generated and a work of confirmation and modification by a user can easily be done. Thereby, a cost required for a complicated relating procedure indispensable to an interactive operating system is reduced.

FIG. 1

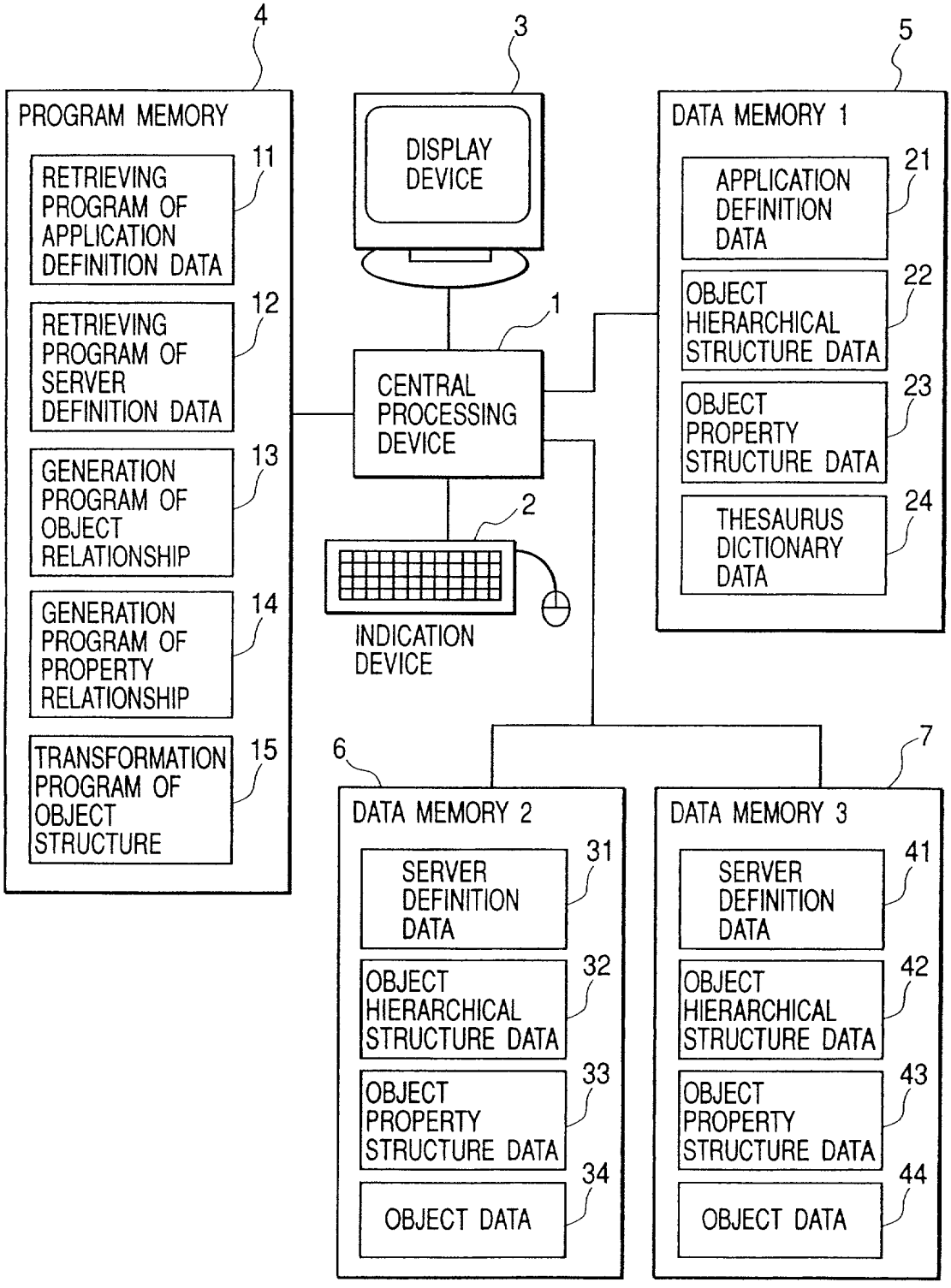

4
PROGRAM MEMORY
11
RETRIEVING PROGRAM OF APPLICATION DEFINITION DATA
12
RETRIEVING PROGRAM OF SERVER DEFINITION DATA
13
GENERATION PROGRAM OF OBJECT RELATIONSHIP
14
GENERATION PROGRAM OF PROPERTY RELATIONSHIP
15
TRANSFORMATION PROGRAM OF OBJECT STRUCTURE
3
DISPLAY DEVICE
1
CENTRAL PROCESSING DEVICE
2
INDICATION DEVICE
5
DATA MEMORY 1
21
APPLICATION DEFINITION DATA
22
OBJECT HIERARCHICAL STRUCTURE DATA
23
OBJECT PROPERTY STRUCTURE DATA
24
THESAURUS DICTIONARY DATA
6
DATA MEMORY 2
31
SERVER DEFINITION DATA
32
OBJECT HIERARCHICAL STRUCTURE DATA
33
OBJECT PROPERTY STRUCTURE DATA
34
OBJECT DATA
7
DATA MEMORY 3
41
SERVER DEFINITION DATA
42
OBJECT HIERARCHICAL STRUCTURE DATA
43
OBJECT PROPERTY STRUCTURE DATA
44
OBJECT DATA

FIG. 2

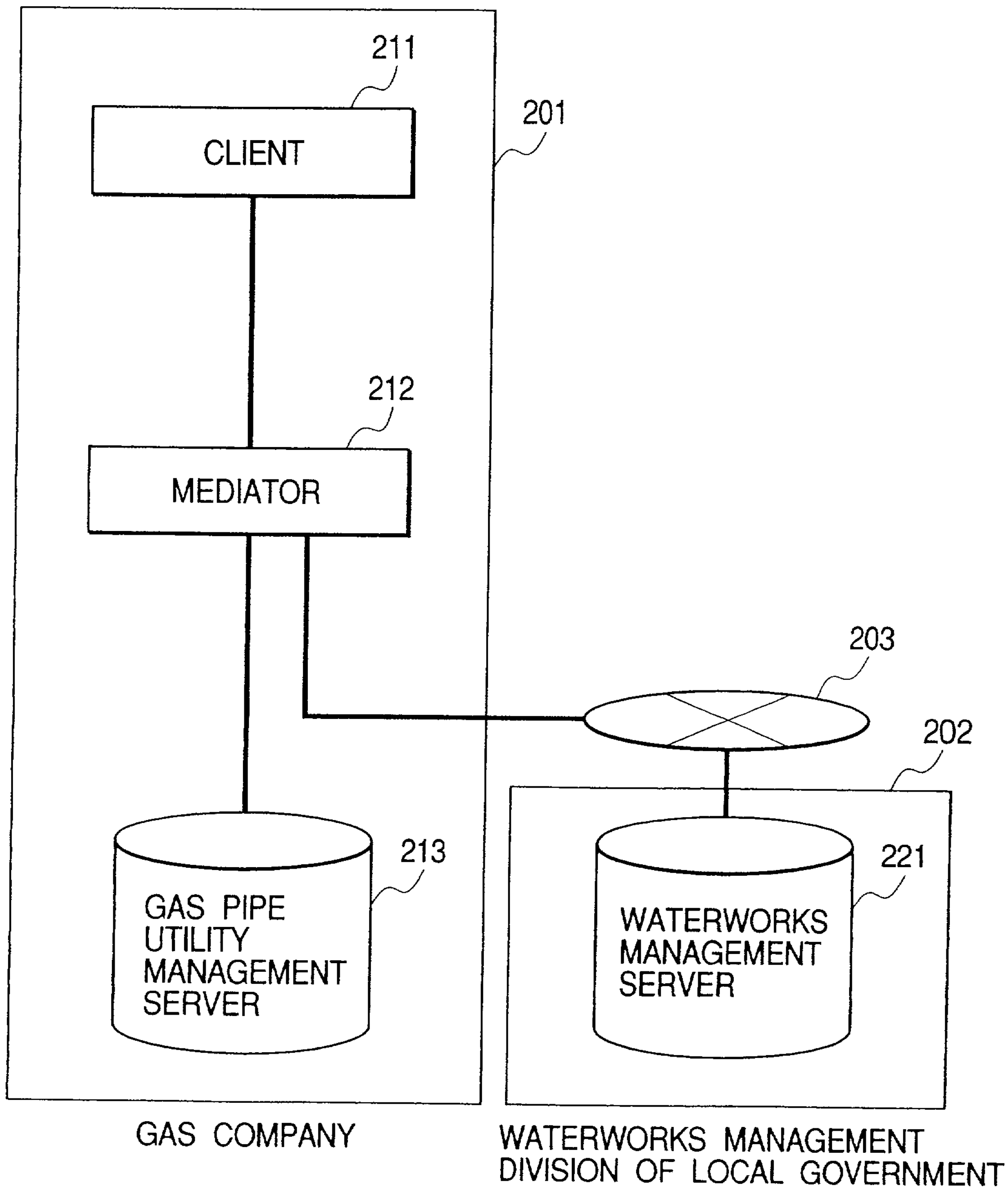
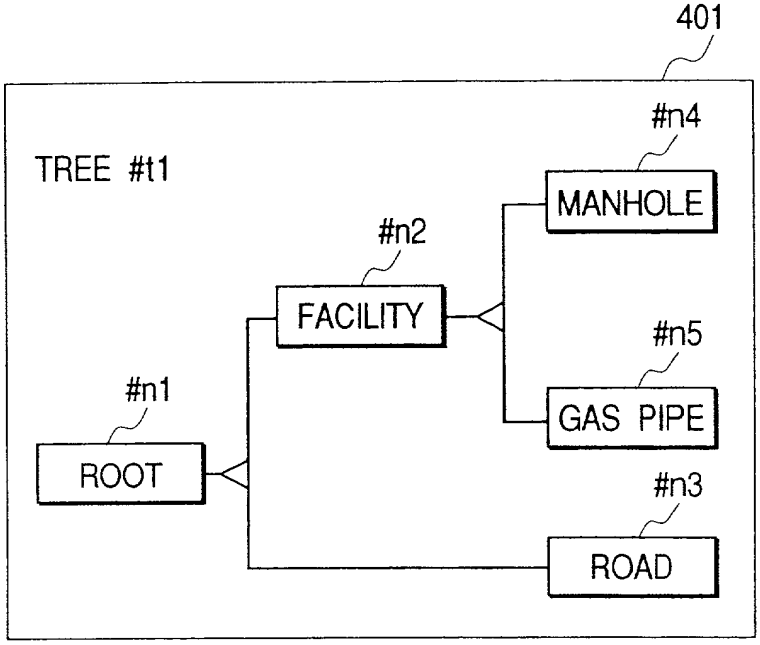

211
CLIENT
201
212
MEDIATOR
203
202
213
GAS PIPE UTILITY MANAGEMENT SERVER
221
WATERWORKS MANAGEMENT SERVER
GAS COMPANY
WATERWORKS MANAGEMENT DIVISION OF LOCAL GOVERNMENT

FIG. 3

301

APPLICATION NAME	GAS FACILITY MANAGEMENT	CUSTOMER INFORMATION MANAGEMENT	...
COORDINATE SYSTEM	NATIONAL STANDARD NO. N SYSTEM	NATIONAL STANDARD NO. N SYSTEM	...
AREA OF OPERATION	{CENTER X, CENTER Y, WIDTH, HEIGHT}	{CENTER X', CENTER Y', WIDTH', HEIGHT'}	...
SCALE	1/500	1/2,500	...
UNIT	cm	m	...
UPDATE TIME	MAR. 1999	MAR. 1998	...
TARGET OBJECT	{GAS PIPE, MANHOLE, ROAD}	{BUILDING, ROAD}	

FIG. 4



402

DATA STRUCTURE OF TREE #t1

NODE ID	NAME	PARENT NODE ID	CHILD NODE ID
#n1	ROOT	NULL	{#n2, #n3}
#n2	FACILITY	#n1	{#n4, #n5}
#n3	ROAD	#n1	NULL
#n4	MANHOLE	#n2	NULL
#n5	GAS PIPE	#n2	NULL

FIG. 5

UTILITY — 501

PROPERTY NAME	DATA TYPE
IDENTIFIER	INTEGER
SET UP DATA	TIME
FIGURE DATA	GEOMETRY

MANHOLE — 502

PROPERTY NAME	DATA TYPE
IDENTIFIER	INTEGER
SET UP DATA	TIME
CALIBER	INTEGER
DEPTH	INTEGER
FIGURE DATA	GEOMETRY

GAS PIPE — 503

PROPERTY NAME	DATA TYPE
IDENTIFIER	INTEGER
SET UP DATA	TIME
CALIBER	INTEGER
LENGTH OF PIPE	INTEGER
FIGURE DATA	GEOMETRY

ROAD — 504

PROPERTY NAME	DATA TYPE
NAME	VARCHAR
CLASSIFICATION	STRING
WIDTH	INTEGER
FIGURE DATA	GEOMETRY

FIG. 6

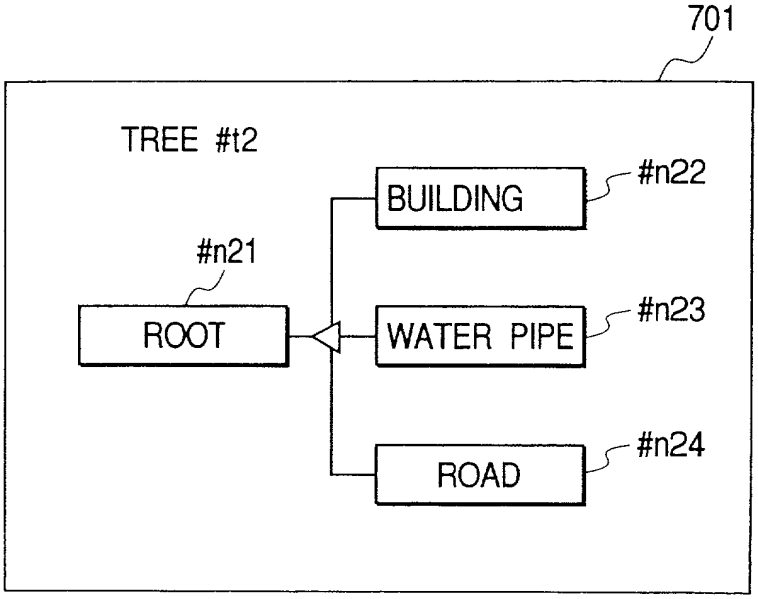
601

SERVER NAME	GAS FACILITY MANAGEMENT SERVER
COORDINATE SYSTEM	NATIONAL STANDARD NO. N SYSTEM
MANAGEMENT AREA	{CENTER X, CENTER Y, WIDTH, HEIGHT}
SCALE	1/500
UPDATE TIME	DEC. 1999
OBJECT NAME	{PIPE, MANHOLE, ROAD}

602

SERVER NAME	WATERWORKS MANAGEMENT SERVER
COORDINATE SYSTEM	NATIONAL STANDARD NO. N SYSTEM
MANAGEMENT AREA	{CENTER X, CENTER Y, WIDTH, HEIGHT}
SCALE	1/1,500
UPDATE TIME	APR. 1999
OBJECT NAME	{BUILDING, WATER PIPE, ROAD}

FIG. 7



702

DATA STRUCTURE OF TREE #t2

NODE ID	NAME	PARENT NODE ID	CHILD NODE ID
#n21	ROOT	NULL	NULL
#n22	BUILDING	#n21	NULL
#n23	WATER PIPE	#n21	NULL
#n23	ROAD	#n21	NULL

FIG. 8

BUILDING

801

PROPERTY NAME	DATA TYPE
CUSTOMER NUMBER	INTEGER
HOUSEHOLDER	STRING
ADDRESS	STRING
TELEPHONE NUMBER	INTEGER
FIGURE DATA	GEOMETRY

WATER PIPE

802

PROPERTY NAME	DATA TYPE
IDENTIFIER	INTEGER
UPDATE TIME	TIME
CALIBER	INTEGER
LENGTH	INTEGER
FIGURE DATA	GEOMETRY

ROAD

803

PROPERTY NAME	DATA TYPE
NAME	STRING
CLASSIFICATION	STRING
WIDTH	INTEGER
FIGURE DATA	GEOMETRY

FIG. 9

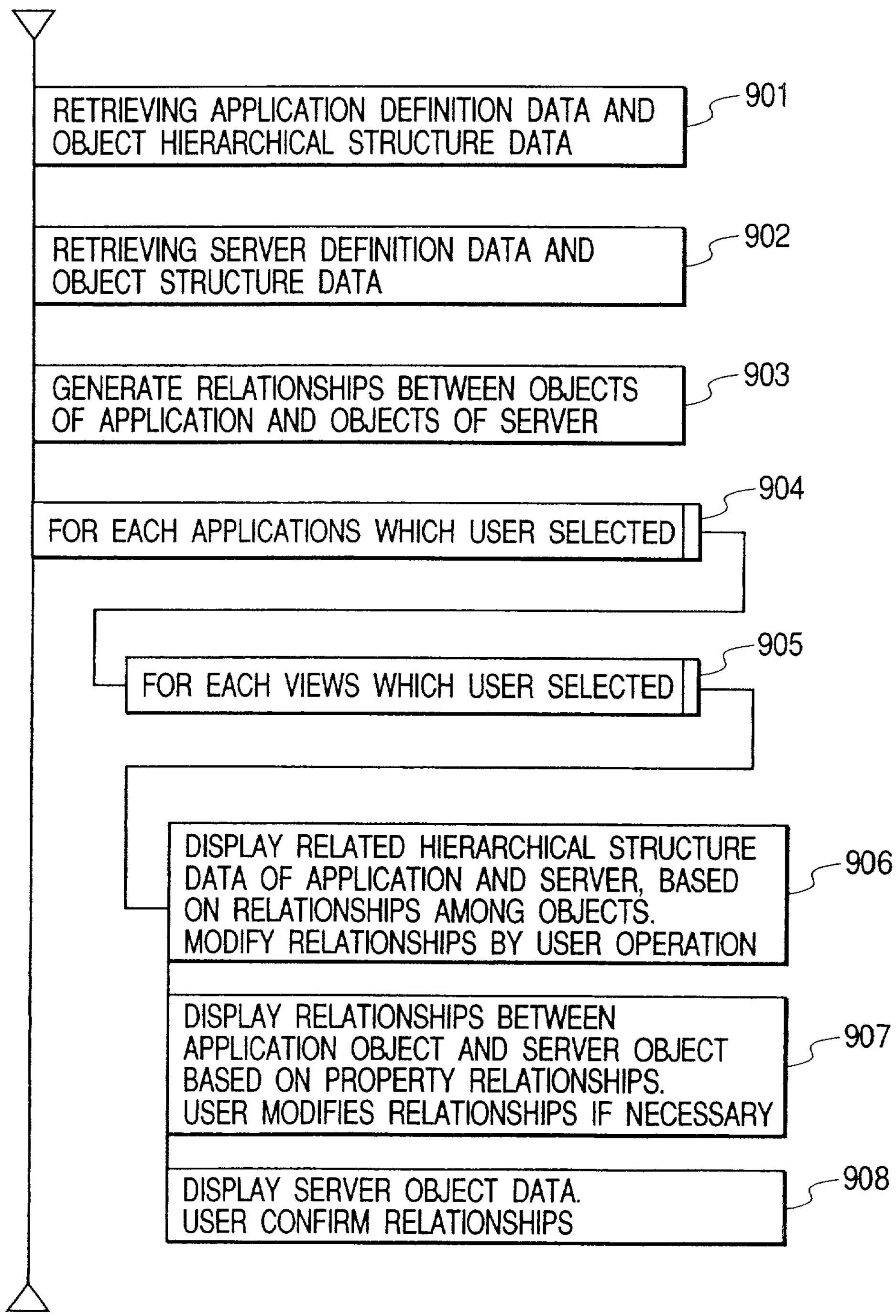

RETRIEVING APPLICATION DEFINITION DATA AND OBJECT HIERARCHICAL STRUCTURE DATA
901
RETRIEVING SERVER DEFINITION DATA AND OBJECT STRUCTURE DATA
902
GENERATE RELATIONSHIPS BETWEEN OBJECTS OF APPLICATION AND OBJECTS OF SERVER
903
FOR EACH APPLICATIONS WHICH USER SELECTED
904
FOR EACH VIEWS WHICH USER SELECTED
905
DISPLAY RELATED HIERARCHICAL STRUCTURE DATA OF APPLICATION AND SERVER, BASED ON RELATIONSHIPS AMONG OBJECTS. MODIFY RELATIONSHIPS BY USER OPERATION
906
DISPLAY RELATIONSHIPS BETWEEN APPLICATION OBJECT AND SERVER OBJECT BASED ON PROPERTY RELATIONSHIPS. USER MODIFIES RELATIONSHIPS IF NECESSARY
907
DISPLAY SERVER OBJECT DATA. USER CONFIRM RELATIONSHIPS
908

FIG. 10

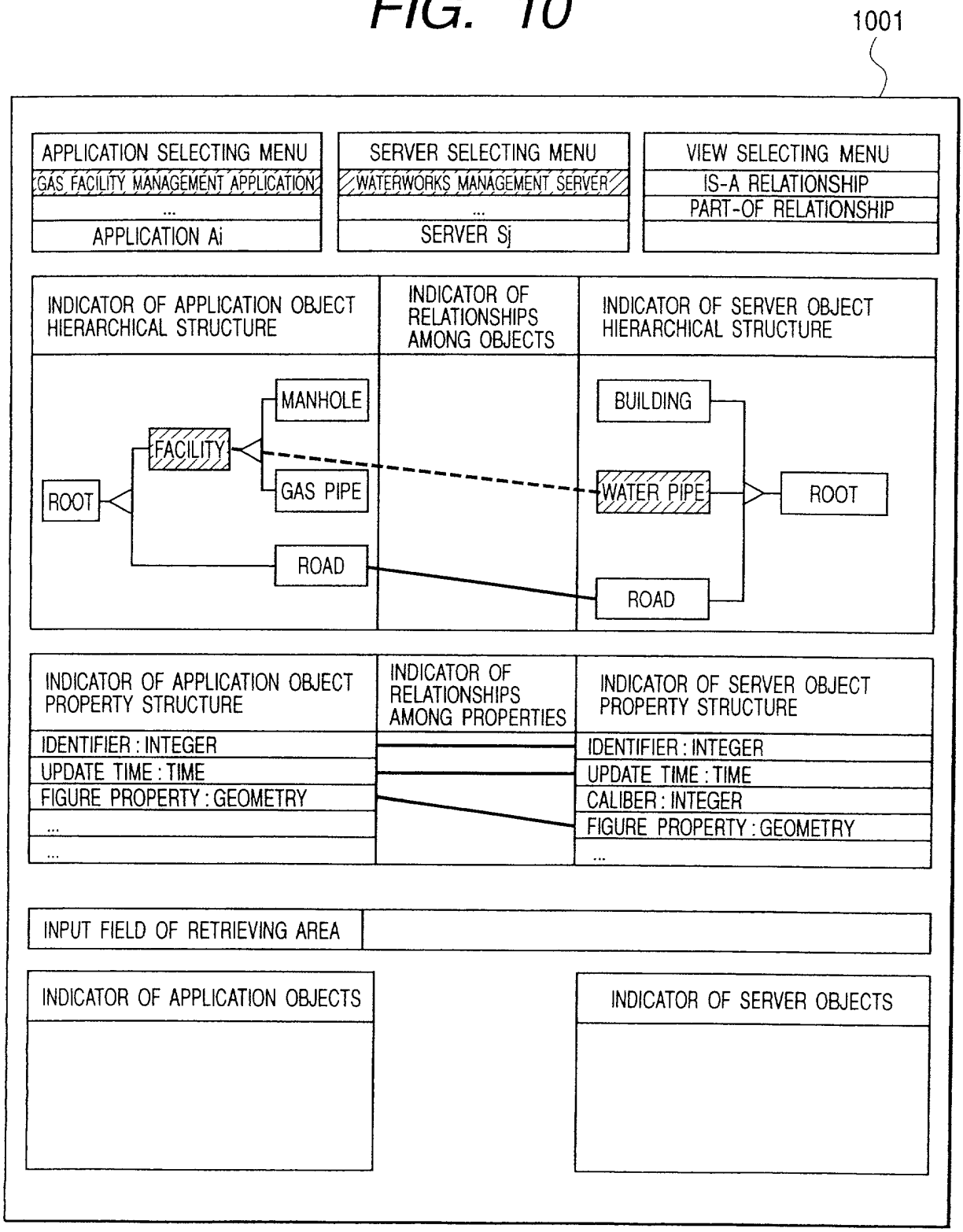
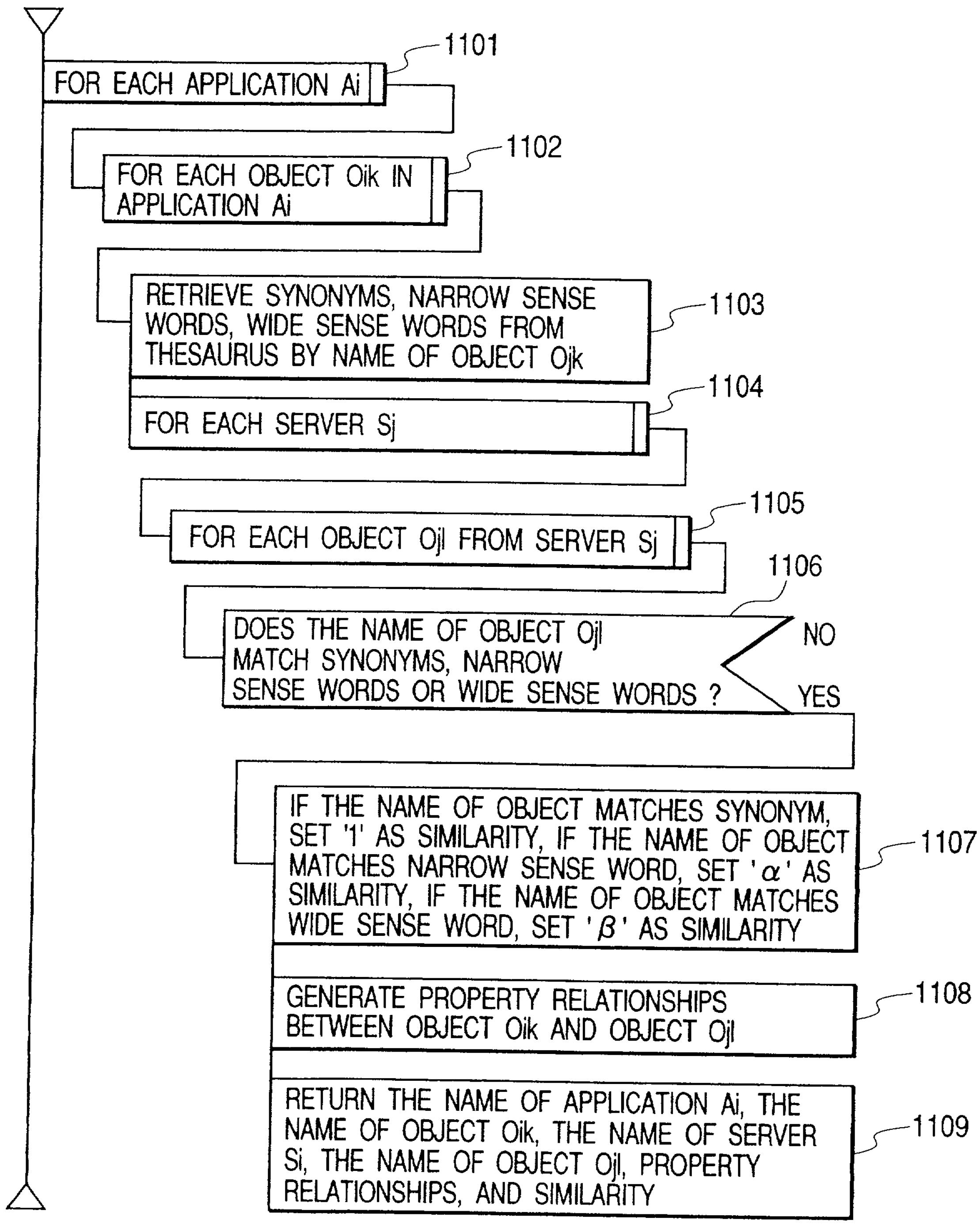

1001
APPLICATION SELECTING MENU
GAS FACILITY MANAGEMENT APPLICATION
...
APPLICATION Ai
SERVER SELECTING MENU
WATERWORKS MANAGEMENT SERVER
...
SERVER Sj
VIEW SELECTING MENU
IS-A RELATIONSHIP
PART-OF RELATIONSHIP
INDICATOR OF APPLICATION OBJECT HIERARCHICAL STRUCTURE
INDICATOR OF RELATIONSHIPS AMONG OBJECTS
INDICATOR OF SERVER OBJECT HIERARCHICAL STRUCTURE
ROOT
FACILITY
MANHOLE
GAS PIPE
ROAD
BUILDING
WATER PIPE
ROOT
ROAD
INDICATOR OF APPLICATION OBJECT PROPERTY STRUCTURE
INDICATOR OF RELATIONSHIPS AMONG PROPERTIES
INDICATOR OF SERVER OBJECT PROPERTY STRUCTURE
IDENTIFIER : INTEGER
UPDATE TIME : TIME
FIGURE PROPERTY : GEOMETRY
...
...
IDENTIFIER : INTEGER
UPDATE TIME : TIME
CALIBER : INTEGER
FIGURE PROPERTY : GEOMETRY
...
INPUT FIELD OF RETRIEVING AREA
INDICATOR OF APPLICATION OBJECTS
INDICATOR OF SERVER OBJECTS

FIG. 11



FOR EACH APPLICATION Ai
1101
FOR EACH OBJECT Oik IN APPLICATION Ai
1102
RETRIEVE SYNONYMS, NARROW SENSE WORDS, WIDE SENSE WORDS FROM THESAURUS BY NAME OF OBJECT Ojk
1103
FOR EACH SERVER Sj
1104
FOR EACH OBJECT Ojl FROM SERVER Sj
1105
DOES THE NAME OF OBJECT Ojl MATCH SYNONYMS, NARROW SENSE WORDS OR WIDE SENSE WORDS ?
1106
NO
YES
IF THE NAME OF OBJECT MATCHES SYNONYM, SET '1' AS SIMILARITY, IF THE NAME OF OBJECT MATCHES NARROW SENSE WORD, SET 'α' AS SIMILARITY, IF THE NAME OF OBJECT MATCHES WIDE SENSE WORD, SET 'β' AS SIMILARITY
1107
GENERATE PROPERTY RELATIONSHIPS BETWEEN OBJECT Oik AND OBJECT Ojl
1108
RETURN THE NAME OF APPLICATION Ai, THE NAME OF OBJECT Oik, THE NAME OF SERVER Si, THE NAME OF OBJECT Ojl, PROPERTY RELATIONSHIPS, AND SIMILARITY
1109

FIG. 12

1201

TARGET WORD	SYNONYMS	NARROW SENSE WORDS	WIDE SENSE WORDS
ROAD	{STREET, AVENUE}	{FREEWAY, HIGHWAY,...}	{TRANSPORTATION}
BUILDING	{STRUCTURE,...}	{HOUSE,...}	{CONSTRUCTION}
RAILWAY	{RAILROAD, TRAMWAY...}	{NATIONAL RAILWAY, PRIVATE RAILWAY...}	{TRANSPORTATION}
...	...	...	...

FIG. 13

1301

APPLICATION NAME	APPLICATION OBJECT NAME	SERVER NAME	SERVER OBJECT NAME	SIMILARITY
GAS FACILITY MANAGEMENT	ROAD	WATERWORKS MANAGEMENT SERVER	ROAD	1
GAS FACILITY MANAGEMENT	FACILITY	WATERWORKS MANAGEMENT SERVER	WATER PIPE	α
CUSTOMER INFORMATION MANAGEMENT	BUILDING	WATERWORKS MANAGEMENT SERVER	BUILDING	1
CUSTOMER INFORMATION MANAGEMENT	ROAD	WATERWORKS MANAGEMENT SERVER	ROAD	1
...	...	...	...	...

FIG. 14

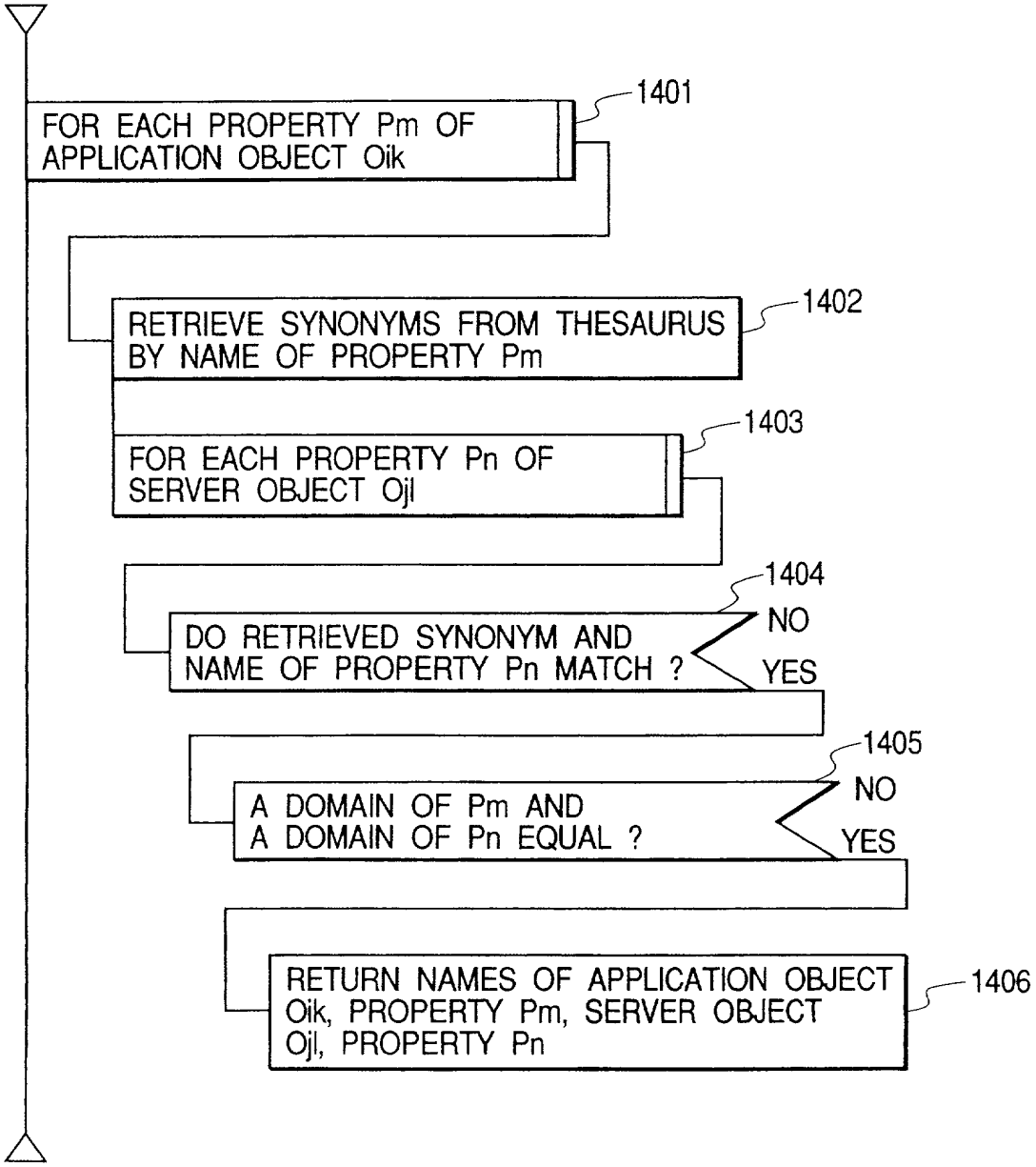

1401
FOR EACH PROPERTY Pm OF APPLICATION OBJECT Oik
1402
RETRIEVE SYNONYMS FROM THESAURUS BY NAME OF PROPERTY Pm
1403
FOR EACH PROPERTY Pn OF SERVER OBJECT Ojl
1404
DO RETRIEVED SYNONYM AND NAME OF PROPERTY Pn MATCH ?
NO
YES
1405
A DOMAIN OF Pm AND A DOMAIN OF Pn EQUAL ?
NO
YES
1406
RETURN NAMES OF APPLICATION OBJECT Oik, PROPERTY Pm, SERVER OBJECT Ojl, PROPERTY Pn

FIG. 15

1501

APPLICATION OBJECT NAME	PROPERTY NAME	PROPERTY DATA TYPE	SERVER OBJECT NAME	PROPERTY NAME	PROPERTY DATA TYPE
FACILITY	IDENTIFIER	INTEGER	WATER PIPE	IDENTIFIER	INTEGER
FACILITY	UPDATE TIME	TIME	WATER PIPE	DATA	TIME
FACILITY	FIGURE PROPERTY	GEOMETRY	WATER PIPE	FIGURE PROPERTY	GEOMETRY
ROAD	ROAD NAME	VARCHAR	ROAD	STREET NAME	STRING
...	...	...	...	...	...

FIG. 16

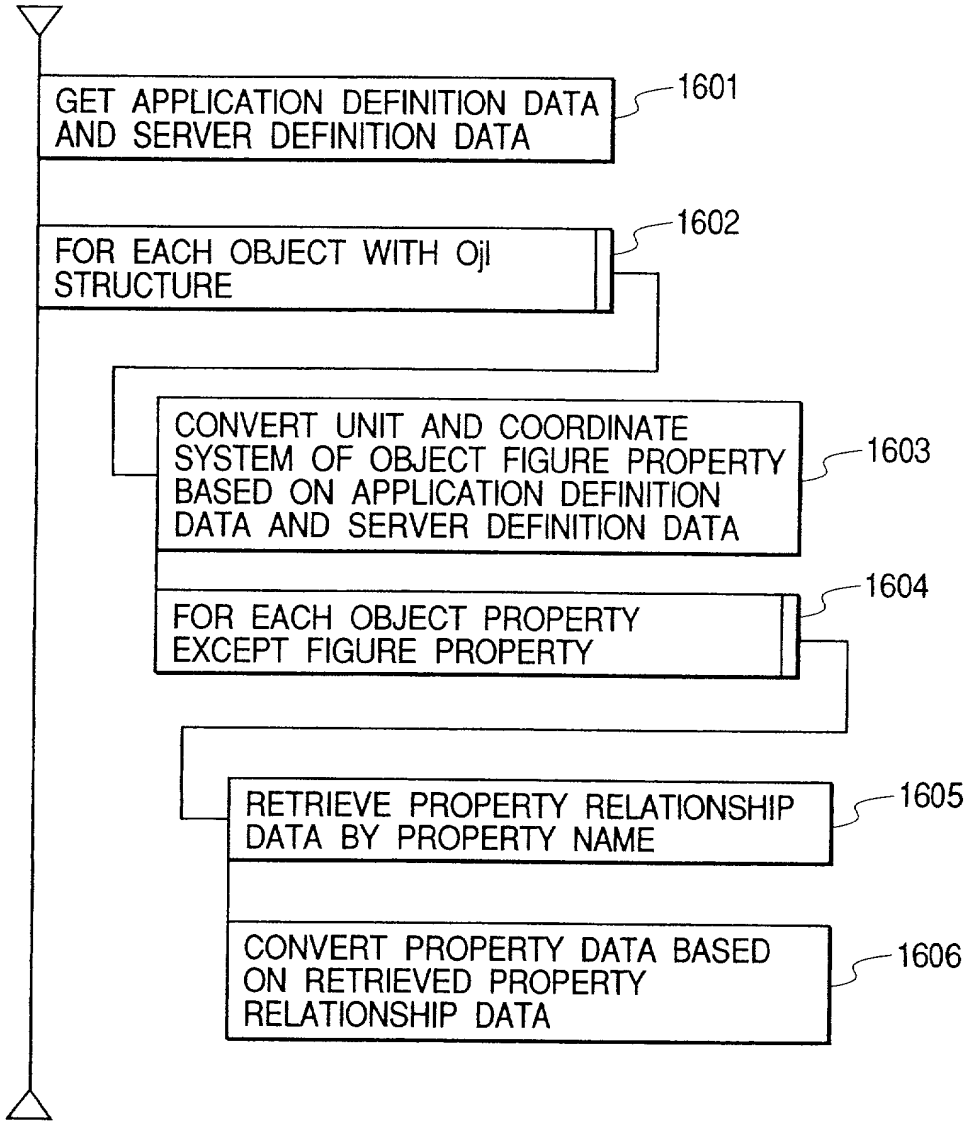
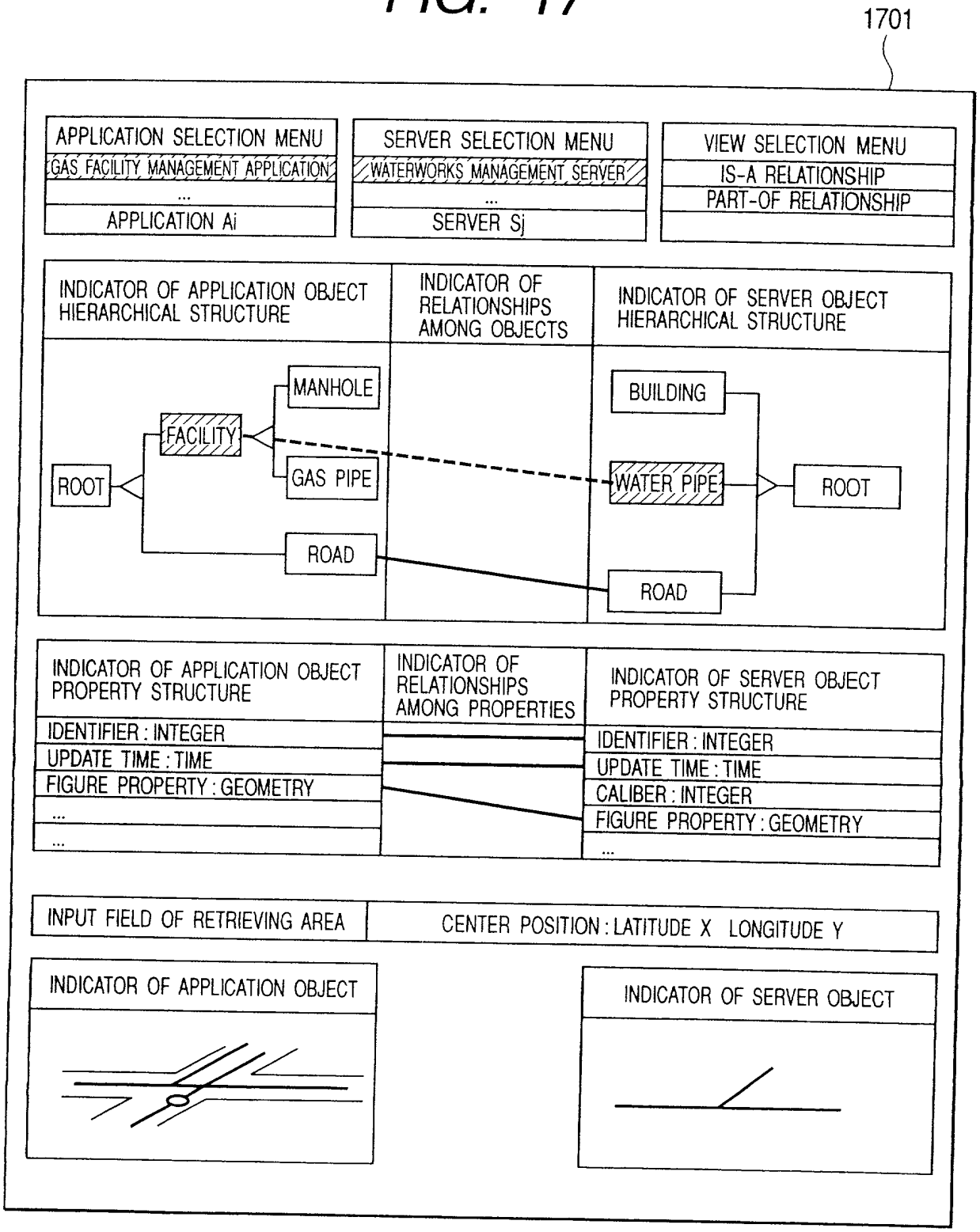

GET APPLICATION DEFINITION DATA AND SERVER DEFINITION DATA
1601
FOR EACH OBJECT WITH Ojl STRUCTURE
1602
CONVERT UNIT AND COORDINATE SYSTEM OF OBJECT FIGURE PROPERTY BASED ON APPLICATION DEFINITION DATA AND SERVER DEFINITION DATA
1603
FOR EACH OBJECT PROPERTY EXCEPT FIGURE PROPERTY
1604
RETRIEVE PROPERTY RELATIONSHIP DATA BY PROPERTY NAME
1605
CONVERT PROPERTY DATA BASED ON RETRIEVED PROPERTY RELATIONSHIP DATA
1606

FIG. 17


1701
APPLICATION SELECTION MENU
GAS FACILITY MANAGEMENT APPLICATION
...
APPLICATION Ai
SERVER SELECTION MENU
WATERWORKS MANAGEMENT SERVER
...
SERVER Sj
VIEW SELECTION MENU
IS-A RELATIONSHIP
PART-OF RELATIONSHIP
INDICATOR OF APPLICATION OBJECT HIERARCHICAL STRUCTURE
INDICATOR OF RELATIONSHIPS AMONG OBJECTS
INDICATOR OF SERVER OBJECT HIERARCHICAL STRUCTURE
ROOT
FACILITY
MANHOLE
GAS PIPE
ROAD
BUILDING
WATER PIPE
ROOT
ROAD
INDICATOR OF APPLICATION OBJECT PROPERTY STRUCTURE
INDICATOR OF RELATIONSHIPS AMONG PROPERTIES
INDICATOR OF SERVER OBJECT PROPERTY STRUCTURE
IDENTIFIER : INTEGER
UPDATE TIME : TIME
FIGURE PROPERTY : GEOMETRY
...
IDENTIFIER : INTEGER
UPDATE TIME : TIME
CALIBER : INTEGER
FIGURE PROPERTY : GEOMETRY
...
INPUT FIELD OF RETRIEVING AREA
CENTER POSITION : LATITUDE X LONGITUDE Y
INDICATOR OF APPLICATION OBJECT
INDICATOR OF SERVER OBJECT

E5234-01
(米)

PTO/SB/106(8-96)
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Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that.

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

DISPLAY METHOD OF SPATIAL DATA RELATIONSHIPS

上記発明の明細書（下記の欄で×印がついていない場合は、本書に添付）は、

The specification of which is attached hereto unless the following box is checked

☐ __月__日に提出され、米国出願番号または特許協定条約国際出願番号を_____とし、
(該当する場合) _____に訂正されました。

☐ was filed on _____
as United States Application Number or
PCT International Application Number
_____ and was amended on
_____ (if applicable)

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above

私は、連邦規則法典第３７編第１条５６項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56

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私は、米国法典第３５編１１９条 (a)-(d) 項又は３６５条(b)項に基き下記の、米国以外の国の少なくとも一カ国を指定している特許協力条約３６５ (a) 項に基ずく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	Priority Not Claimed 優先権主張なし
11-197009	Japan	12 / July / 1999	☐
			☐

私は、第３５編米国法典１１９条 (e) 項に基いて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Application No.) (出願番号)	(Filing Date) (出願日)

私は、下記の米国法典第３５編１２０条に基いて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約３６５条 (c) に基ずく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第３５編１１２条第１項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第３７編１条５６項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1 56 which became available between the filing date of the prior application and the national or PCT international filing date of application.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)
(Application No) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)

私は、私自身の知識に基ずいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じるところに基ずく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第１８編第１００１条に基ずき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

E5234-01
(米)

PTO/SB/106(8-96) (Modulated spacing)
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Patent and Trademark Office, U S DEPARTMENT OF COMMERCE

Japanese Language Declaration
(日本語宣言書)

委任状： 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁護士、または代理人の氏名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (*list name and registration number*)

Donald R. Antonelli, Reg. No 20,296, David T. Terry, Reg. No. 20,178, Melvin Kraus, Reg. No 22,466; William I. Solomon, Reg No. 28,565; Gregory E Montone, Reg. No. 28,141, Ronald J. Shore, Reg No. 28,577, Donald E Stout, Reg. No 26,422, Alan E. Schiavelli, Reg. No 32,087; James N. Dresser, Reg. No. 22,973 and Carl I Brundidge, Reg. No. 29,621

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Direct Telephone Calls to. (*name and telephone number*)

Telephone (703) 312-6600
Fax: (703) 312-6666

唯一または第一発明者名	**Full name of sole or first inventor** Masaaki TANIZAKI
発明者の署名 日付	**Inventor's signature** **Date** Masaaki Tanizaki 4/20/2000
住所	**Residence** Kodaira, Japan
国籍	**Citizenship** Japan
私書箱	**Post Office Address** c/o Hitachi, Ltd., Intellectual Property Group New Marunouchi Bldg. 5-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8220, Japan

(第二以降の共同発明者についても同様に記載し、署名をすること)

(Supply similar information and signature for second and subsequent joint inventors.)

E 5234-01
(米)

PTO/SB/106(8-96)
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第二共同発明者名		**Full name of second joint inventor, if any** Shigeru SHIMADA
第二共同発明者の署名	日付	**Second inventor's signature** **Date** 4/20/2000 Shigeru Shimada
住所		**Residence** Kodaira, Japan
国籍		**Citizenship** Japan
私書箱		**Post Office Address** c/o Hitachi, Ltd , Intellectual Property Group New Marunouchi Bldg. 5-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8220, Japan
第三共同発明者名		**Full name of third joint inventor, if any** Kazunori WATANABE
第三共同発明者の署名	日付	**Third inventor's signature** **Date** Kazunori Watanabe 4/20/2000
住所		**Residence** Yokohama, Japan
国籍		**Citizenship** Japan
私書箱		**Post Office Address** c/o Hitachi, Ltd., Intellectual Property Group New Marunouchi Bldg. 5-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8220, Japan
第四共同発明者名		**Full name of fourth joint inventor, if any** Akira ISHII
第四共同発明者の署名	日付	**Fourth inventor's signature** **Date** Akira Ishii 4/20/2000
住所		**Residence** Yokohama, Japan
国籍		**Citizenship** Japan
私書箱		**Post Office Address** c/o Hitachi Software Engineering Co , Ltd., 81, Onoecho-6-chome, Naka-ku, Yokohama, Japan
第五共同発明者名		**Full name of fifth joint inventor, if any**
第五共同発明者の署名	日付	**Fifth inventor's signature** **Date**
住所		**Residence**
国籍		**Citizenship**
私書箱		**Post Office Address**